Galactic Dust Reddening and Effect on Photometric Redshifts

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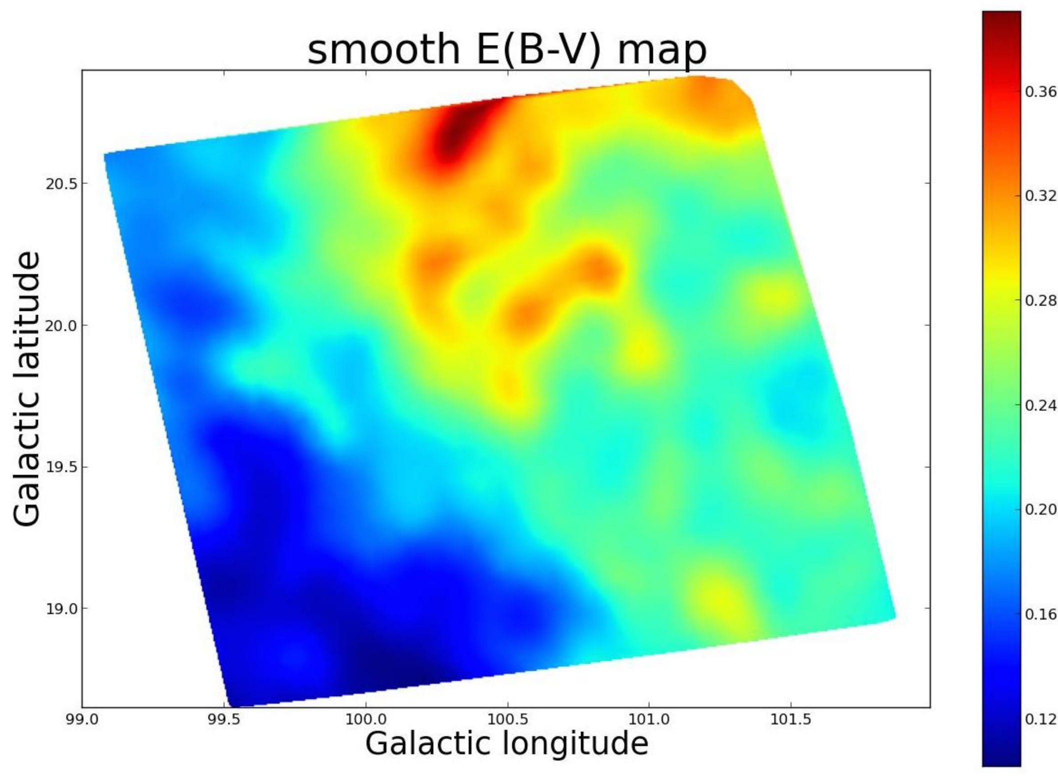
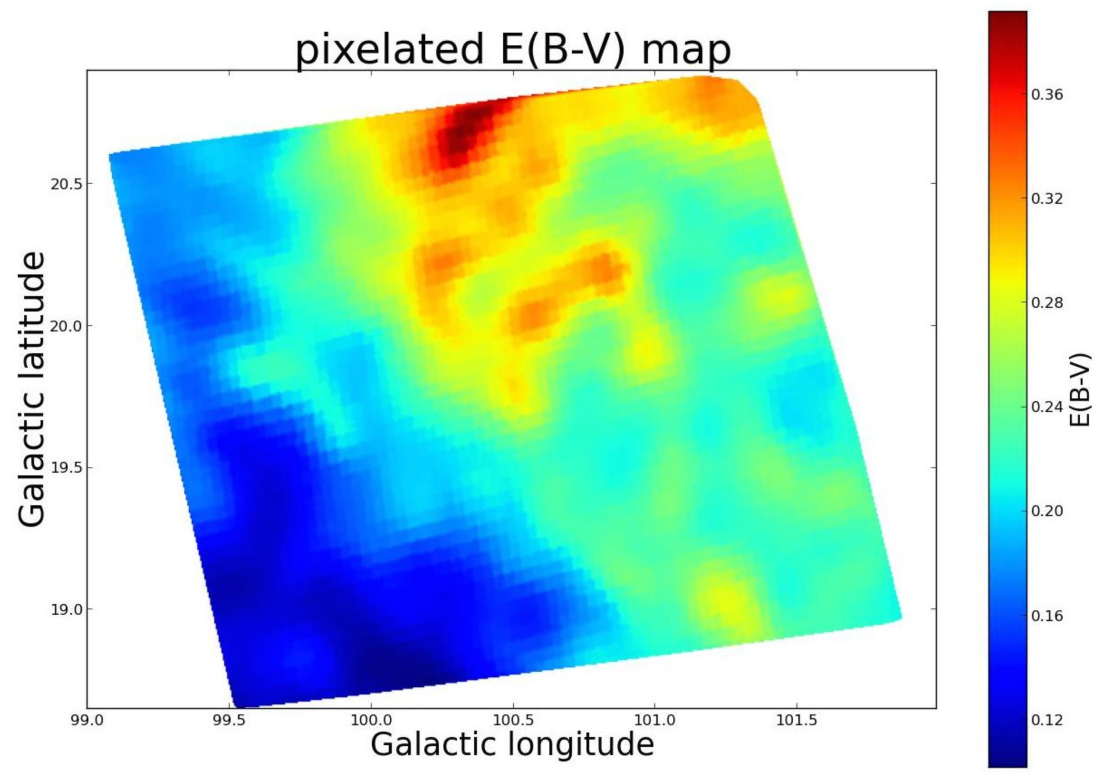
Abstract: To investigate the impact of imperfect removal of Galactic reddening on LSST photometric redshifts, I create a simulation of galaxy photometry in a 4 square degree patch on the sky. I apply Galactic extinction following a continuous version of the SFD dust map, then deredden using only the center point of a pixelized version of the footprint, simulating a low resolution dust map. In addition, I use a different value of Rv than is used to add the mock dust simulating the effects of a mischaracterization of the wavelength dependent absorption of Milky Way dust. For the toy model assumptions made here, the impact on photo-z's due to dereddening errors is minimal, however, further work using more sophisticated assumptions is required.





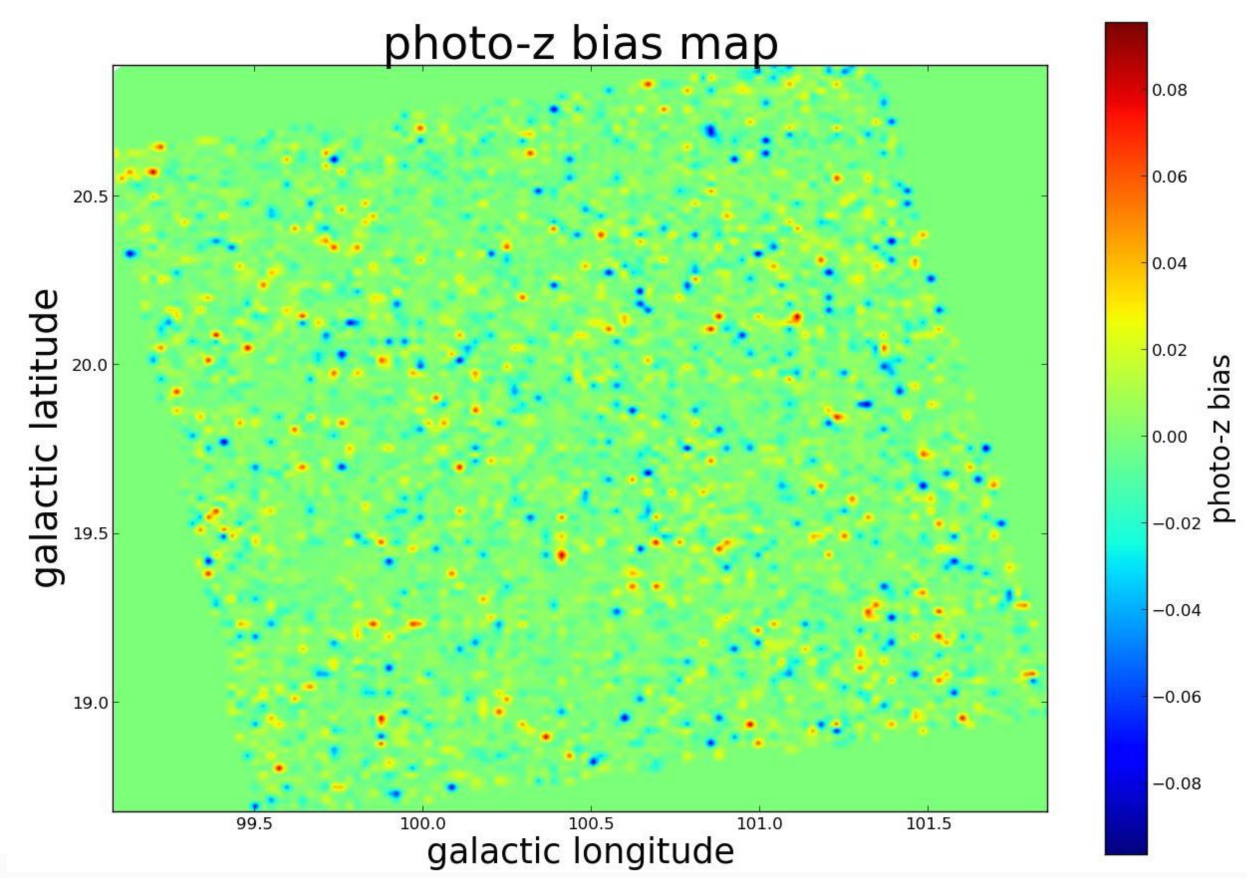
Results

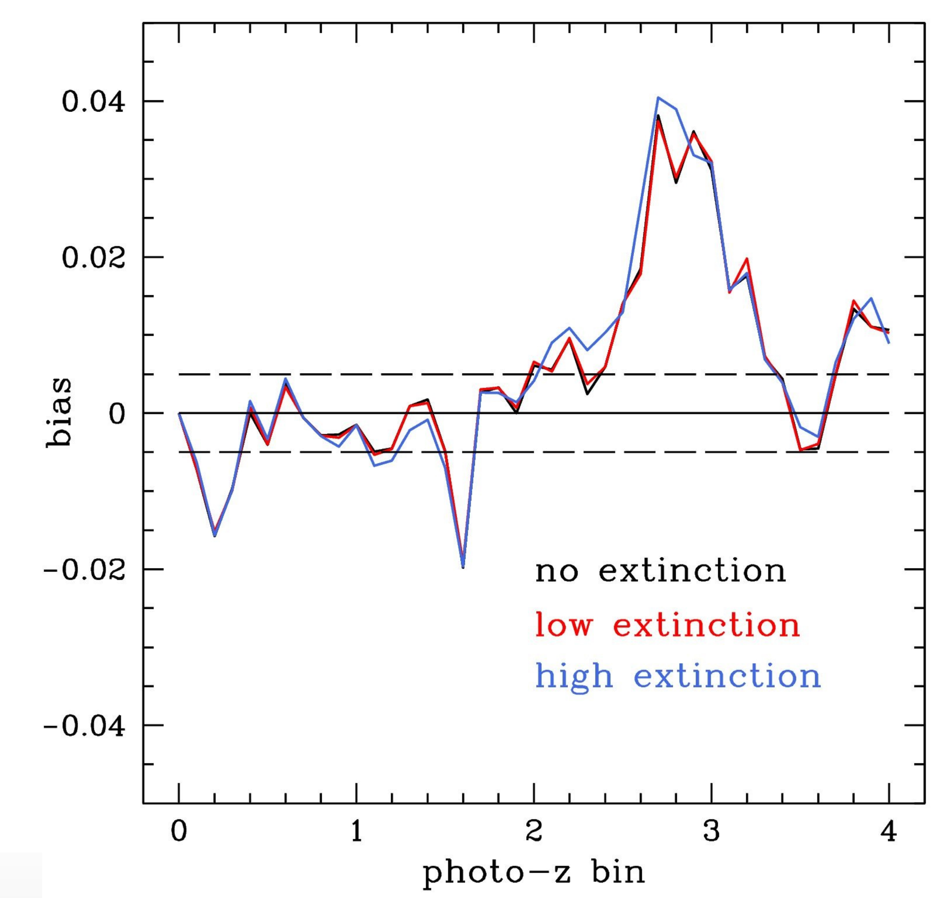
Surprisingly, only a slight (~1-3%) degradation in the bias, scatter, and catastrophic outlier rate is seen in the resultant photo-z values. It appears that the continuous SED variation in the mock galaxies was a more important effect than errors in dereddening, at least given the toy model assumptions used here.

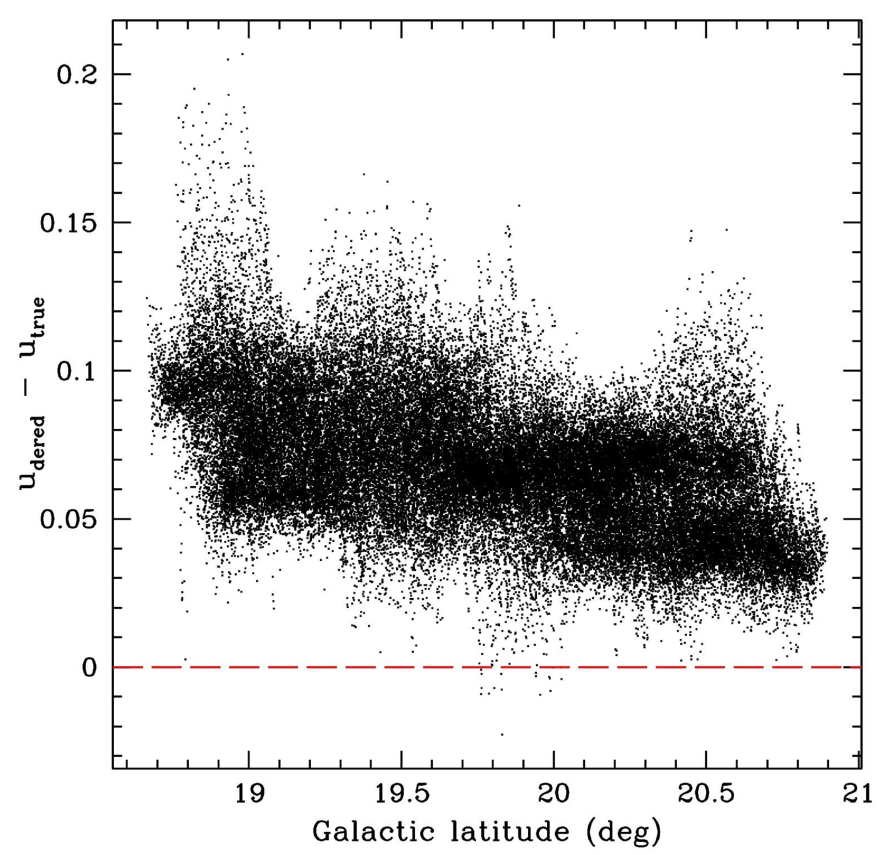
The bias as a function of photo-z bin (below right) shows only a 1-3% increase over the photo-z bias from the sample where dereddening errors were not included. The bias as a function of position on the sky (botllom left) does not show correlations with the magnitude of E(B-V) or its gradient. It appears that the spatial variations are due to the underlying SED distribution, and not the dust.

Smoothed vs Unsmoothed

We use a continuous distribution of galaxy SEDs generated from the Brown et al (2013) spectra to simulate full depth ugrizy photometry and then add the effect of Galactic dust. The smooth version of the map (left), using the SFD99 map with interp=y centered at glon=100 glat=20, with E(B-V) in the range ~0.1-0.4 is used to apply Galactic extinction. while the map with ~3' pixels (right) is used to deredden the simulated galaxies. In addition, We assume Rv=3.3 when applying reddening, but use Rv=3.1 to deredden, leading to an overall bias toward redder colors in the resultant mock galaxy catalog. The resultant shift in the u-band color is shown below







Induced shift in the u-band magnitude as a function of Galactic latitude due to combination of the low-resolution E(B-V) map and incorrect Rv value. The shifts will be identical up to a scale factor determined by the ratio of A_λ for the grizy bands. Thus, nearly all objects in the catalog appear to be more red than they should, given the SED that that was used to generate the true photometry.

Open Questions

These simulations made several simplifying assumptions, and open questions remain:

- For current photo-z algorithms, dust appears subdominant to SED effects. *Will this still be true as photo-z algorithms improve?*
- The map assumed a smooth variation in the dust below scales of ~3 arcmin, *is this smoothness assumption valid? How would increased substructure in the dust affect results?*
- *What other considerations should be included in future studies of dereddening on photo-z?*

References

Brown et al (2014), ApJS, 212, 18

Schlegel, Finkbeiner, & Davis, (1998), ApJ, 500, 525